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Limits of Kansei – Kansei unlimited

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ABSTRACT
This paper discusses momentary limitations of Kansei Engineering methods. There are for example the focus on the evaluation of colour and form factors, as well as the highly time consuming creation of the Kansei questionnaires. To overcome these limits we firstly, suggest the integration of related scientific research results on product emotions etc. in the Kansei questionnaires. Thereafter we present a study on the wide range of Kansei aspects treated in an industrial conception setting. The results together with the literature review lead us to a framework on user-centred product conception aspects. This framework unfolds potential expansion points for Kansei contents. Both perspectives underline the potential of Kansei Engineering for future applications and show our vision of Kansei Engineering beyond the limits.

Keywords
Kansei design, product conception

INTRODUCTION

This paper has for objective to lay open limitations in the application of Kansei Engineering methods in hitherto cases and to propose solutions to overcome these limits. At first Kansei-related research data and tools which might be directly integrated in the conception of Kansei questionnaires are introduced. As a second step, we present a study on Kansei factors during product conception. The findings of the literature review and the study allowed us to establish a framework on Kansei aspects of product conception. It shows aspects, besides semantics of forms and colours, which could potentially be treated through Kansei techniques, for example sensations evoked by textures or emotions triggered by motions. At the end, we discuss the findings under the perspective of Kansei beyond the limits.

FROM SEMANTIC DIFFERENTIALS TO HYBRID KANSEI ENGINEERING SYSTEMS

When Osgood proposed semantic differentials as a tool for measuring meaning in 1957, he provided the base for Kansei Engineering KE [1]. Nagamachi took on the method and created a methodology for the consideration of Kansei in product development [2]. Since then, the KE methods have been applied and refined in many countries, especially in South- and East-Asia. The Japanese word Kansei, commonly translated as "feeling", includes a wide range of words related to style, emotions, affect, and semantic descriptors of products. The goal of KE is to facilitate the evaluation of the Kansei evoked by certain product attributes and to help designers to adapt products to the envisioned user experience. The classic Kansei Engineering proceeds in the following steps [2]:

1. At the beginning a word base needs to be constituted. The researchers collect terms typical for the product and its sector through brainstorming, journals, websites, etc. They select the most adapted words and group them into pairs of semantic differentials.
2. As a second step, rules for the repartition of the product components have to be deducted.
3. A large number of participants evaluate the product or its components on the expression of its attributes – like form or colour – with a questionnaire that contains the previously defined semantic differentials.
4. The results are treated through statistical analysis of the relation between the Kansei values and the chosen attributes.
5. In order to exploit the results of the analytical part in further projects, the data is kept in a data base which is integrated in a Kansei Engineering System. Such a system links Kansei words with forms or colours and can be used as a design tool.

Various Kansei Engineering Systems have been developed to automatically support the design process [3-7]. Sophisticated systems contain interfaces that enable designers to manipulate the design's Kansei instantly through e.g. form or colour modifications.

KE methods have been used in various sectors, including mobile communication [8-10], transportation interior design [11], [12], architecture [4], [13], [14], tools and technical elements [7], [15], shoe design [16-18] and many others.

LIMITS OF KANSEI ENGINEERING METHODS

But even though the KE methods have been successfully implemented in the above listed wide range of projects, there remain certain limitations to their application.

1. The most evaluated aspects to this day are forms and colours. Of the analysed research papers on Kansei Engineering nearly 40% looked at the Kansei of form factors, about 15% related Kansei with colours and 10% combined both, form and colour. Most of the other papers presented advancements of the algorithms and methods for statistical analysis. Discussions among the Kansei community in social

networks already propose different ideas to expand KE application to other fields of human interaction, e.g. advertisement or project management [19].

2. Today's KES are project-specific and can hardly be used in other contexts. Their development is very costly in terms of time and resources because a new set of Kansei words and questionnaires has to be developed for each product. Schütte already proposed a generic software to quickly create Kansei questionnaire forms [20]. However, the intense work on the word base is still required.

3. Kansei evaluations are mostly done based on static images of finished products instead of real objects, concepts or their interfaces. This limits the possibilities to influence the design during the conception process. Furthermore, it inhibits an interaction between user and object and therefore use sequences cannot be tested on their Kansei impact. Lately we see first works from design researchers who have taken on evaluation of use sequences to overcome this limitation [21].

4. Kansei evaluation is mainly done on tangible factors of predefined product components. Modifications on each of these product elements can improve the Kansei of the whole object. However, a revision of the component structure, which is also an important part of designing, is not encouraged by the KE methods.

5. The KE measurement usually takes into account the emotions at the moment of first contact. However the Kansei towards a stimulus changes constantly with new insights, progressing understanding or loss of interest. To draw conclusions on the medium- and long-term effects of design's Kansei, the time component needs to be integrated into the methodology. Here too design researchers start to propose first approaches [22].

BEYOND THE LIMITS

Despite these momentary limitations, we believe that Kansei Engineering continues to be a promising approach for the development of user-centred products. To overcome the shortcomings and to explore the presumably unlimited possibilities of Kansei Design, we propose to take into account the manifold research results from neighbouring disciplines like sociology or physiology and to widen the factors taken into account as impacting on Kansei.

Literature review on Kansei-related research data

We reviewed research publications in search of potentially complementary tools from Kansei-related fields. Our focus here lay on established word lists which could significantly accelerate the cumbersome creation of project specific Kansei questionnaires (the second identified limitation of today's KE methods). Sets of Kansei words could be a) generic, b) sector specific or c) product specific.

Looking at research from psychology, sociology and ergonomics, we find abundant material on emotions and values as well as usability. We can comfortably access schemas that contain all possible states of human *emotions* and extract those important for design. There are, for example, the Geneva Emotion Wheel [23],Plutchik's multi-dimensional model of emotions and his word-pair list [24], as well as the fourteen basic emotions (in English, Dutch, Finnish and Japanese) elicited by products proposed by Desmet [25]. To access *emotions* stimulated by a product design, lexical methods like semantic differentials are not the only means. Lang's Self-Assessment Manikin SAM as well as Desmet's animated PrEmo character are both visual tools that bring a playful and universal component to the evaluation activity [26].

Sensations by their nature are limited through the available number of senses – visual, audible, tactile, olifactif, gustatory, etc. The *sensation* describing words are therefore very closely related to physical product properties. For a basic vocabulary, we appreciate the work of Karana who assembled a list of verbal appraisals on perceived tactile or visual properties of materials [27]. Another rich vocabulary was proposed by Zuo et al. who extracted a primary and a secondary "minimum lexicon" on tactile textures. It contains geometrical, physical, emotional and associative dimensions [28].

The science of ergonomics divides *usability* into three elements: efficiency, effectiveness and satisfaction. While the first two can be measured through performance parameters (time, quantity, quality, etc.); satisfaction can only be accessed through self-evaluation for the moment [29]. In previous Kansei studies undergone by our Master students we found that the notion of satisfaction or the attitude towards the product or brand has a great influence on the rating of the semantic differentials. If people dislike a certain brand they tend to assign semantic descriptors that express things they find negative in general, regardless of the product's actual expression. Same goes for people who are completely indifferent towards the product. We therefore agree with Mantelet who suggests evaluating the participant's satisfaction in Kansei questionnaires [30]. To better understand the user's reactions, Mantelet also proposes to integrate questions about the user's *values* at the beginning of Kansei questionnaires. A often cited reference and good word base is Rokeach's values list [31]. A Master student of our laboratory successfully adopted this list for the evaluation of the coherence of the product designs with the brand image [32]. Equally interesting is Schwartz' "Model of Relations between Motivational Values" [33] which is based on human values which were found consistent between 40 countries.

While the previously discussed aspects can be represented through a limited number of possible conditions, the number of *semantic* terms to describe a product is merely infinite. Therefore literature review cannot provide us with an exhaustive list. However, our previous studies have shown that certain terms, for example: dynamic, comfortable, funny, luxurious, etc., are used by many participants. This means that there exist generic terms for certain types of products and sectors. Here collaborative work between all members of the Kansei community is desirable to establish a Kansei word pool.

Discussion

This collection of references on Kansei words and related measurement methods is far from complete. Especially on sensation describing words, further resources are still to be revealed. Many KE researchers have probably already used some of the mentioned lists in the course of the creation of their questionnaires. We will continue the collection and evaluation of these tools and hope to share experiences on their practicability with the Kansei community.

Study on tangible and intangible aspects treated during product conception

After this excursion into research literature, this second part of the paper will look at real product designs. The different research tendencies already point at the complexity of product Kansei. It cannot be ignored that there are various features, besides form and colour (as stated under the first current limitation), which influence the Kansei of the user. To identify all product aspects that elicit Kansei, we conducted a study on the design conception of a fictive product in an industrial setting.

Methods

The study had for objective to detect all user and product related aspects treated by designers and engineers during the conception of consumer products and to indentify relations between these aspects. Eleven professionals from two French companies participated. One was a design agency, the other a manufacturer of telecommunication devices. Among the participants were five product designers, three graphic designers, and three engineers. The task was to generate a purely lexical design concept for: “A communicating coffee machine for Adidas”.

The study consisted of two parts. First, each professional faced the fictive brief and underwent a mind mapping during one hour. They were asked to note all words on post-its, place them on a paper surface and link related words with marker lines. The duplication or relocation of words was allowed. The participants were repeatedly encouraged to simultaneously verbalize their thoughts which enabled the researchers to follow their reflexion during the activity. Following this individual exercise, the produced words were united into a word pool and classed by three researchers. The participants assembled and received a marker of a different colour each. During 45 minutes they could choose words from the pool, position them on a wall, and mark relations between words with drawn lines. Thereby we encouraged discussion on the choice of relations among the participants. Everybody who agreed on a chosen link marked it with a line of his colour.

The study was videotaped. All mind maps were reproduced in Adobe Illustrator. The noted words were sorted and listed in excel tables. The data was statistically analysed on the absolute and relative word occurrence par identified aspects. Furthermore a data base was programmed, to register all linked word pairs. The data base helped to extract the absolute and relative quantity of relations between words of different categories. We normalized the data by dividing the absolute number of links between two conception aspects by the product of words assigned to them.

$$\text{normalized value} = \text{number of links between two aspects} \;/\; (\text{number of words in aspect 1} \times \text{number of words in aspect 2})$$

Results in general

Each participant produced a mind map. Another mind map was developed by the whole team in both companies. Figure 1 shows one product designer’s individual production. In Figure 2 the collective mind map of one company is illustrated.

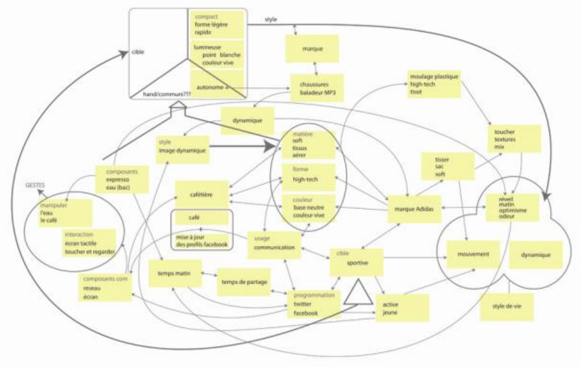

Figure 1: A participant’s individual mind mapping.

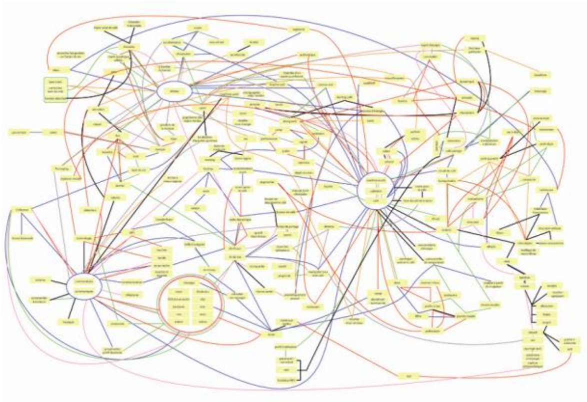

Figure 2: Collective mind map in one company.

The maps include 513 conception words (mostly in French, for this paper examples were translated into English). Furthermore, the participants linked pairs of these words about 861 times (in average 78.3 links per person) during the individual phase. The group activity amplified the number of links to 1790, which is equivalent to 174.5 links per person.

Result 1: Occurrence of tangible and intangible aspects during product conception

Among the identified aspects were product properties like form (e.g. strait, open, symmetrical), colour (e.g. green, red, golden), material (e.g. polyamide, carbon, wood), texture (e.g. brilliant, craggy, smooth), and patterns (e.g. arabesque, point, small squares). Furthermore we found words related to technical functionalities (e.g. geo-localization, aeration, power supply), product components (e.g. body housing, screen, battery), and basic aspects of production (e.g. casting, injection, engraving). We call them tangible aspects.

The array of found attributes related to the user ranges from values (e.g. liberty, sustainability, reliability) to semantic product descriptors (e.g. dynamic, classic, feminine), sensations (e.g. warm, soft, aromatic), and emotions (e.g. assuring, pleasant, funny), words that describe a specific style (e.g. edge, retro-cool, pop-art), and analogies which transport a metaphoric idea (e.g. like a water drop, dragonfly, magic lantern). We also classed gestures of the user to interact with the product (e.g. touch, rotate, push, scroll), words related to the expected macro function of the product (e.g. communication, protection, leisure), the use context (e.g. morning, at home, rendezvous), and the target user (e.g. adolescent, early adopter, family) under these intangible aspects.

Table **2** shows all identified aspects and their definition.

The statistical analysis of all 513 terms allowed us to estimate the pertinence of each conception aspect.

Table 1 shows the percentage distribution of the collected words under the identified aspects.

Tangible aspects								Intangible aspects									
Form	Colour	Material	Texture	Patterns	Functionality	Components	Procedures	Values	Context	Target user	Analogies	Semantics	Sensations	Emotions	Style	Gestures	Functions
3.8 %	2.6 %	4.4 %	3.6 %	0.4 %	18.2 %	7.6 %	3.2 %	8 %	6.8 %	5.1 %	12.4 %	8.9 %	4.1 %	0.6 %	1 %	6.7 %	2.6 %
43,8%								56,2%									

Table 1: Percentage distribution of conception words in the identified conception aspects, 513 words.

We find slightly more than half of all mentioned concept words under intangible aspects (56.2%). The importance of both, tangible and intangible, aspects was balanced. The attributes containing most conception words were analogies (12.4%) and semantic descriptors (8.9%) on the intangible side and functionalities (18.2%) on the tangible side. Style and emotions on the intangible and procedures on the tangible side were the groups with the least number of words.

	Aspect	Definition
Tangible aspects	Form	The visible contour
	Colour	The visual property of an object produced as a result of light reflection and emission*
	Material	The matter from which a thing is made* or seems to be made off
	Texture	The appearance or consistency of a surface*
	Patterns	A decorative image or design, a dominant or recurring idea*
	Functionality	A technical solution to facilitate the expected function
	Components	Means to implement the expected functionalities of the product
	Procedures	Procedures of fabrication and assembling
Intangible aspect	Values	One's judgement of what is important in life*
	Context	The circumstances that form the setting for an event *, like time, place and social environment of the envisioned product use
	Target User	A person selected to use or operate the product
	Analogies	A comparison between one thing and another *, inspirations, conceptual references
	Semantics	Adjectives that describe the product, its meaning
	Sensations	A feeling resulting from something that comes into contact with the body* (sound, taste, smell, touch)
	Emotions	A strong instinctive or intuitive feeling deriving from one's circumstances, mood, or relationships*
	Style	A way of painting, writing, composing, building, etc., characteristic of a particular period, place, person, or movement*
	Gestures	A movement of part of the body, especially a hand or the head, to express an idea or meaning*, to interact with the product
	Function	Practical use or purpose of a design*

Table 2 : List of conception aspects, *definitions based on Oxford dictionary.

Result 2: Relations between tangible and intangible aspects of product conception

To investigate the relation between the different tangible and intangible conception aspects, the links on the idea maps, produced by the participants during the study, were analyzed. The normalized repartition of links between tangible and intangible aspects can be seen in Table 3.We state the following connections:

1. Words belonging to the same aspect were frequently related. We find strong connections among colours, materials, forms, and words defining target users. The same applies on a slighter level for words belonging to texture, values, sensations, and gestures.

2. Between tangible aspects, colours were often related to forms. Materials were often paired with textures. And patterns show multiple links with texture too.

	Form	Colour	Material	Texture	Pattern	Function	Component	Procedure	value	Context	Target User	Analogy	Semantic Descriptor	Sensation	Emotion	Style	Gesture
Form	0.038																
Colour	0.059	0.054															
Material	0.011	0.014	0.047														
Texture	0.015	0.014	0.039	0.022													
Pattern			0.015	0.030													
Functionality	0.003	0.002	0.001	0.002	0.002	0.014											
Component	0.008	0.004	0.008	0.010		0.009	0.006										
Procedure	0.004	0.012	0.007	0.013		0.008	0.013	0.017									
Value	0.008	0.007	0.006	0.001		0.008	0.002	0.015	0.024								
Context	0.005	0.001	0.002	0.002		0.012	0.003	0.004	0.024	0.014							
Target User	0.003		0.003			0.015	0.002	0.005	0.013	0.030	0.065						
Analogy	0.014	0.006	0.010	0.007	0.004	0.016	0.010	0.005	0.008	0.010	0.013	0.009					
Semantic	0.017	0.002	0.022	0.024	0.006	0.010	0.005	0.011	0.020	0.011	0.011	0.011	0.015				
Sensation		0.002	0.016	0.003		0.008	0.004	0.007	0.007	0.005	0.003	0.007	0.007	0.026			
Emotion		0.015				0.004	0.010	0.012				0.006	0.010	0.038			
Style	0.066	0.075		0.018		0.001			0.010			0.015	0.029				
Gesture	0.009	0.005	0.001	0.010		0.009	0.013	0.009	0.004	0.005	0.009	0.005	0.012	0.009	0.006		0.026

Table 3: Normalized repartition of links made between conception aspects.

3. Between intangible aspects, values were frequently related to semantic product descriptors and to words describing the use context. The context also appeared often together with terms on target users. Furthermore, emotions and sensations very closely related.

4. Strong links between tangible and intangible aspects were formed between style and forms as well as between style and colours. And semantic descriptors where frequently related to material and texture.

5. Pattern, style and emotions were the groups with the least number of words and therefore, despite the normalization, a complete lack of links with many aspects appeared.

Discussion

We gathered a wide base of lexical data related to the conception of a product. Sorting and statistical analysis of these terms enabled us to identify various types of tangible and intangible aspects of product conception. The obtained data allowed us to see tendencies in the occurrence of the various aspects. However, the level of abstraction between the found tangible and intangible aspects (

Table **2**) differs strongly. Some of them are features (e.g. components or functionalities) while others are the characterization of these features (e.g. colours or semantics) [34]. The level of granularity of the categories varies. Theoretically, procedures and components could be further sub-categorized into fabrication, assemblage, etc. Only their occurrence was too low to create relevant subcategories.

Looking at the data from the point of view of Kansei methods, forms and colours were well represented on the tangible side. But we also found a wide range of complementary product properties like texture, material, patterns which might make a difference for the user experience. Kansei relevant aspects like semantic product describing adjectives, emotions, and sensations had their place among the terms identified on the intangible side during the fictive conception process. Looking at the wide spectrum of found aspects, we propose to broaden the Kansei space to all these factors and effects of design on the human. As such we consider values and analogies (associations evoked by the design) as part of Kansei too.

Our second objective was to lay open relations between the tangible and intangible aspects of product conception. The fact that intra-category links appeared frequently might be due to their contextual proximity. The other found links like between material and texture or style and form correspond to the common sense of the profession. They show that designers and engineers today already hold the knowledge to estimate the consecutive consequences of choices on one aspect like material on others like colour, values or functionalities. However, the mind maps (Figure 1and Figure 2) illustrate the complexity of the knowledge which has to be treated in the design process. Here the Kansei Engineering tools could be deployed to take into account relations between enlarged tangible and intangible conception aspects.

A framework of complex Kansei relations

The findings of the study and the literature review nourished our proposition of a framework that includes the identified tangible and intangible aspects of product conception (Figure 3).

Like the "framework of aesthetic interaction" [35], our framework too has two poles: the user's Kansei and the materialization in the product. The cognitive flow is triggered by tangible aspects of the product, e.g. the form, the colour, or the material. They stimulate the user's receptors and are being perceived through comparison with memory contents. If the stimuli is identified as relevant, the user shows an emotional or/and a motoric response. E.g. a particular reflection raises his interest and he reaches out to move the object. Now a new stimulus, for example the soft surface, is being perceived and responded to. This cycle is called the "sensorimotor coupling" [36].

If we look at the human side, we see a number of factors which can potentially be addressed through Kansei Design. There are semantics and emotions, social values, sensations, as well as aspects related to usability – satisfaction, effectiveness and efficiency [29]. We refer to them as "intangible aspects of product conception". On the side of the artefact are the product features and their characteristics [34]. They form the stimuli and include product characteristics like form, colour, material, texture, motion, and function of the product and its components. Furthermore, externally visible components, parts of the product architecture and modes of fabrication or joining can also potentially stimulate the user. We use the term "tangible aspects" of product conception to group aspects directly related to the product. While the same product might stimulate different intangible aspects in different users, we consider the perception of the tangible aspects of this same product consistent between all users, except in case of cognitive or physical limitations.

Discussion: Perspectives of Kansei beyond the limits

The literature review and the study have allowed us a first step to think of Kansei methods that overcome actual limits. For example, to overcome the first identified limitation (focus on colour and form), we propose an extension of the Kansei space. To do so one can consult the introduced "framework of complex Kansei relations" to choose which aspects on the intangible side (the user) and which on the tangible side (the product) are relevant for the product. Then the Kansei methods can be adapted to these points. Another interesting source to widen the Kansei space is the list of Kansei Study Keywords assembled by Levy, Nakamori and Yamanaka. It gives an overview on the manifold contents which are already being considered important by the KE community [37].

The introduced word-lists from related research fields can be consulted by Kansei Designers for the establishment of Kansei questionnaires, which was the second limitation. To respond to the third and forth limitation (3. Kansei evaluations mostly based on static images of finished products and 4. on a predefined product architecture) we think it is indispensible to apply Kansei methods from the early design phase onwards. At the beginning of the design process there is still lots of uncertainty and at the same time there are plentiful opportunities for the product design. Continuous Kansei evaluations on intermediate design representations – like scenarios, sketches, 3D models, dummy interfaces, interactive prototypes etc. – can bring the designers and engineers useful insights for a better product Kansei. The involvement of potential users through Kansei evaluations over the whole course of product development is one step to test more than the reaction to static stimuli only. If the user first emerges into the use scenario and later tests the prototypes in

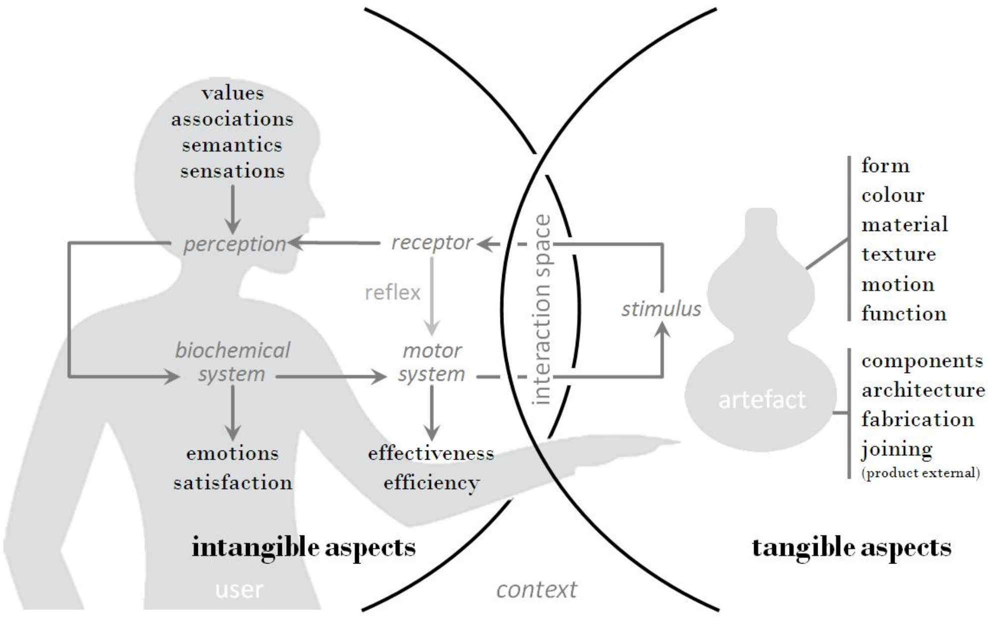

Figure 3: Framework of Kansei relations – the experience flow from the user's point of view.

action, he can evaluate use sequences.

As already mentioned, the semantic differentials are not the only possible method for Kansei Design. Characters like those of Desmet or Lang can change the monotonous filling of a word based questionnaire while even providing reliable results. As already proposed by other Kansei researchers, physiological and comportmental measures can complete the Kansei Engineering methods. They allow the researcher to unveil unconscious relations between visual stimuli and emotional responses [38], [39].

Now the interesting challenge we see is to investigate which combination of methods is the most pertinent to measure the impact of which tangible aspect on the Kansei.

CONCLUSION

This paper had for objective to show limitations of Kansei that became visible during the literature study on Kansei Engineering related projects. To address some of the limitations, we proposed to enlarge the understanding of Kansei relevant aspects.

References from literature were presented which might be used for a simplified creation of meaningful Kansei questionnaires. We reviewed research results of Kansei-related disciplines and proposed some useful collections of words describing emotions, values, etc., as well as some additional measurement techniques.

A study was conducted to identify a wide range of intangible (values, semantics, analogies, emotions, and sensations) and tangible aspects (form, colour, material, texture, functionalities, motions, components, and production procedures). These can all potentially become elements of Kansei studies.

We finished with a brief outlook on how the applications of Kansei Methods could evolve in the near future. One option to augment the pertinence of Kansei evaluation would be its application throughout the whole product design process, and in particular on dynamic product representations like scenarios or interfaces.

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